

L Number	Hits	Search Text	DB	Time stamp
1	149	(438/350).CCLS.	USPAT; US-PGPUB	2002/07/31 17:09
2	1554	"internal base" or "external base"	USPAT; US-PGPUB	2002/07/31 17:10
4	54052	438/\$.ccls.	USPAT; US-PGPUB	2002/07/31 18:18
5	204	("internal base" or "external base") and 438/\$.ccls.	USPAT; US-PGPUB	2002/07/31 17:10
3	13	((438/350).CCLS.) and ("internal base" or "external base")	USPAT; US-PGPUB	2002/07/31 17:25
6	246	buie	USPAT; US-PGPUB	2002/07/31 17:25
7	49683	triple	USPAT; US-PGPUB	2002/07/31 17:25
8	10	buie and triple	USPAT; US-PGPUB	2002/07/31 17:26
9	143526	internal with external	USPAT; US-PGPUB	2002/07/31 18:18
10	54002	bipolar	USPAT; US-PGPUB	2002/07/31 18:19
11	3939	(internal with external) and bipolar	USPAT; US-PGPUB	2002/07/31 18:19
12	4260	(internal with external) with base	USPAT; US-PGPUB	2002/07/31 18:19
13	164	((internal with external) and bipolar) and ((internal with external) with base)	USPAT; US-PGPUB	2002/07/31 18:19
14	315948	@ad>19990812 or @rlad>19990812	USPAT; US-PGPUB	2002/07/31 18:20
15	150	((((internal with external) and bipolar) and ((internal with external) with base)) not (@ad>19990812 or @rlad>19990812)	USPAT; US-PGPUB	2002/07/31 18:21
16	515738	concentration	USPAT; US-PGPUB	2002/07/31 18:21
17	25	concentration with ((internal with external) with base)	USPAT; US-PGPUB	2002/07/31 18:21
18	24	(concentration with ((internal with external) with base)) not (@ad>19990812 or @rlad>19990812)	USPAT; US-PGPUB	2002/07/31 18:22

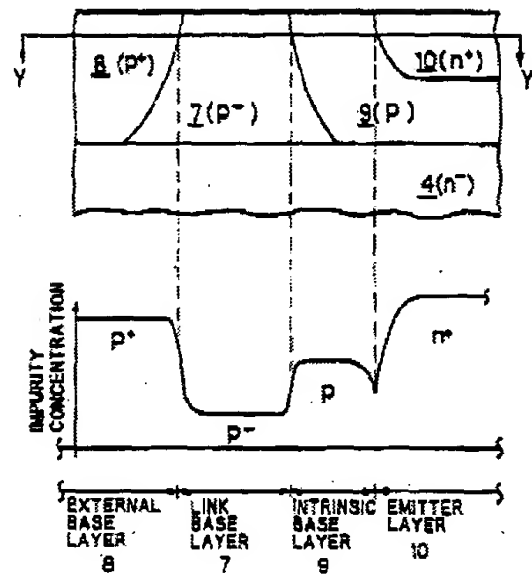
external/internal
intrinsic/extrinsic

~ Sage (with) Jarroun & Quiller

L Number	Hits	Search Text	DB	Time stamp
1	149	(438/350).CCLS.	USPAT; US-PGPUB	2002/07/31 17:09
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5	204	("internal base" or "external base") and 438/\$.ccls.	USPAT; US-PGPUB	2002/07/31 17:10
3	13	((438/350).CCLS.) and ("internal base" or "external base")	USPAT; US-PGPUB	2002/07/31 17:25
6	246	buie	USPAT; US-PGPUB	2002/07/31 17:25
7	49683	triple	USPAT; US-PGPUB	2002/07/31 17:25
8	10	buie and triple	USPAT; US-PGPUB	2002/07/31 17:26

U.S. Patent Jan. 2, 1996 Sheet 2 of 9 5,480,816

FIG. 2



U.S. Patent Oct. 28, 1996 Sheet 2 of 10 5,569,611

Fig. 3 PRIOR ART

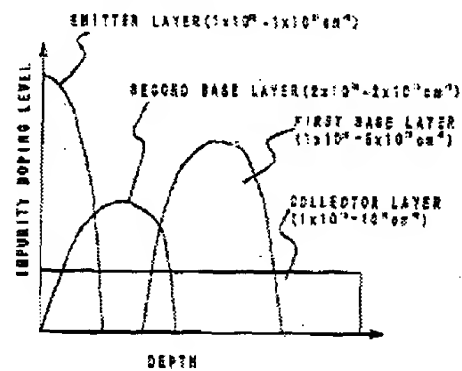
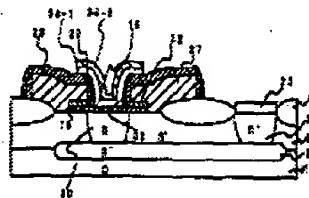


Fig. 15





PATENTED OCT 10 1972

3,697,827

SHEET 2 OF 3



FIG. 1A



FIG. 3A



FIG. 4A

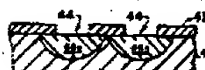


FIG. 11



FIG. 12

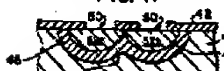


FIG. 13

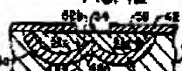


FIG. 14

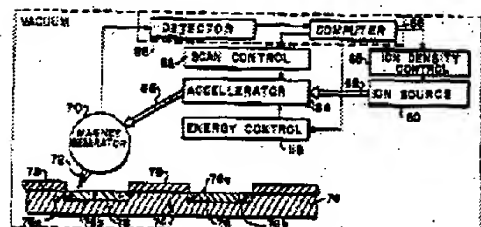


FIG. 15

INVENTOR
EDWARD SIMON
BY *William J. Schaefer*
ATTORNEYS

U.S. Patent Sep. 21, 1976 Sheet 3 of 3 3,981,072

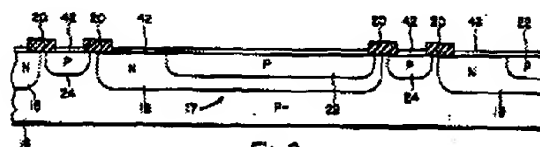


Fig. 9



Fig. 10



Fig. 11

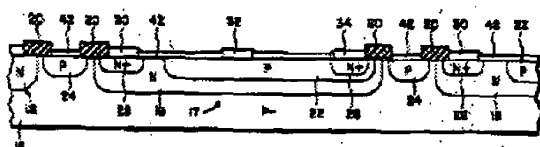


Fig. 12

PATENTED MAY 27 1975

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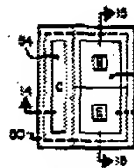


Fig. 13



Fig. 14



Fig. 15

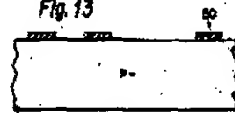


Fig. 16



Fig. 17

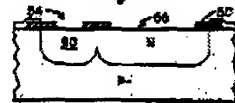


Fig. 18

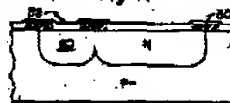


Fig. 19

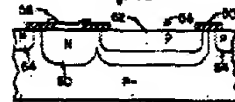


Fig. 20

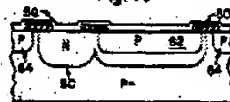


Fig. 21

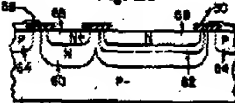


Fig. 22

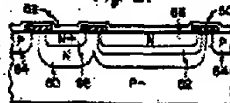


Fig. 23



Fig. 24



Fig. 25



PATENTED MAY 27 1975

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Fig. 9



Fig. 10



Fig. 11

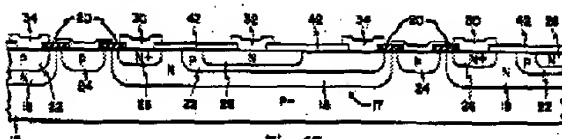


Fig. 12

United States Patent of
Michel et al.4,111,720
Sep. 8, 1978[54] METHOD FOR FORMING A
NON-SPATIAL BIPOLAR INTEGRATED
CIRCUIT[52] Invention: Michel et al., Chicago, Robert O.
Schwartz, Hopewell Junction,
James F. Kistler, Putnam Valley, et
al. N.Y.[73] Assignee: International Business Machines
Corporation, Armonk, N.Y.

[32] Appl. No.: 789,348

[33] Filed: Mar. 21, 1977

[31] Int. Cl.: H01L 21/04, H01L 21/22

[32] U.S. Cl.: 359/100, 359/101, 359/102

[33] Field of Search: 359/100, 359/101, 359/102

[43] References Cited

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Engler et al., "Self-Isolating Bipolar ... by Ion
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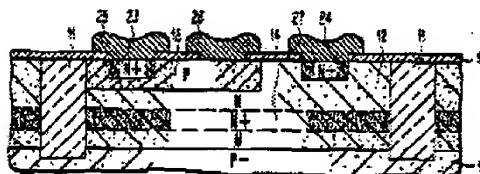
Primary Examiner—S. Dean
Assistant Examiner—Gordon Roy
Attorney Agent—Messrs. J. R. Kistler

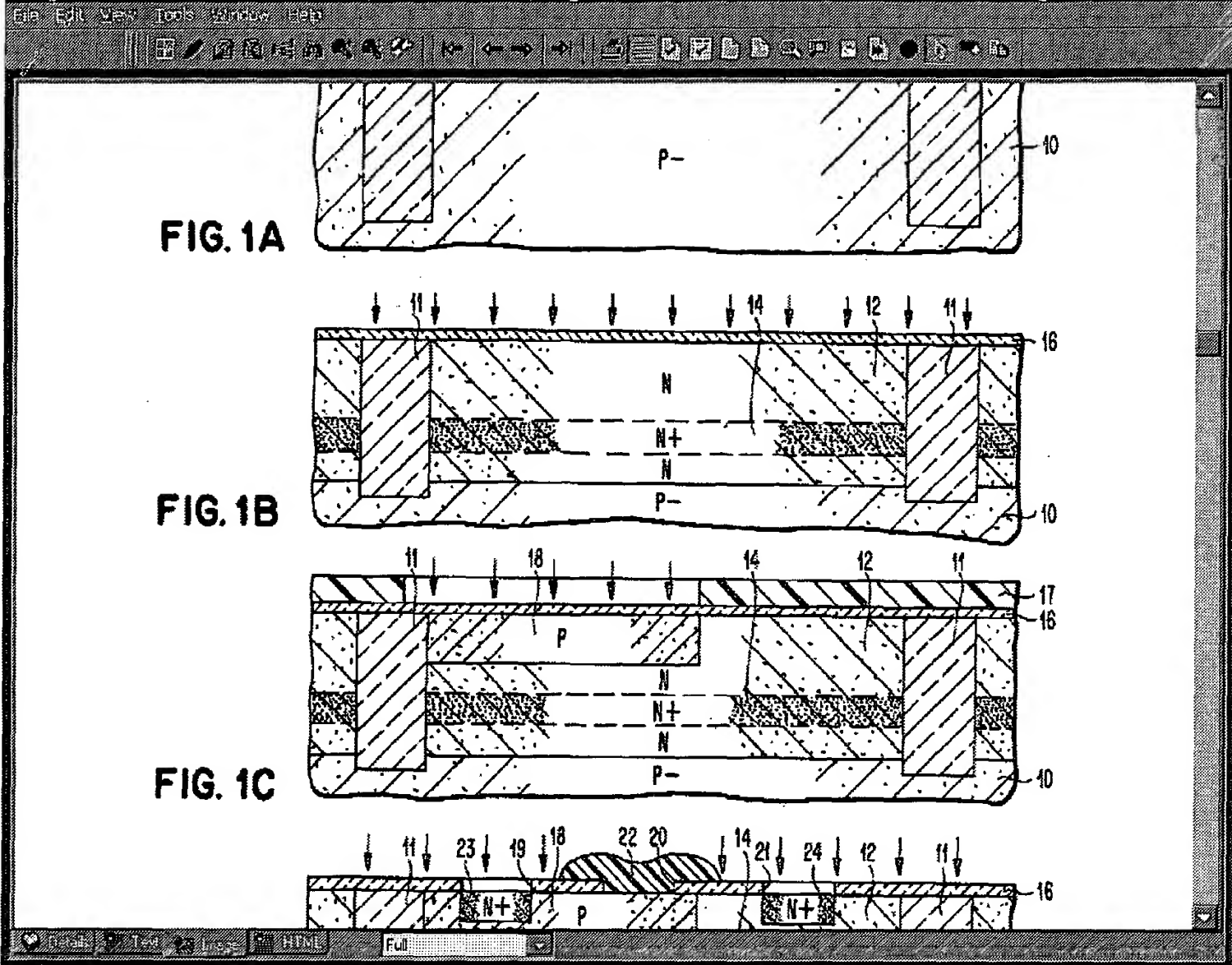
[57] ABSTRACT

A method for forming a non-spatial bipolar integrated circuit comprising first forming a silicon substrate of one-type of conductivity, second forming a second region of conductivity into the substrate and heavily doping it from one surface of the silicon substrate of said one-type conductivity. Then, forming by ion implantation the first region of opposite-type conductivity which is fully enclosed laterally by said second silicon substrate. This region is formed by directing a beam of ions of opposite-type conductivity having at least one surface of the silicon substrate of said one-type conductivity. Then, forming by ion implantation the first region of opposite-type conductivity which is fully enclosed laterally by said second silicon substrate. This region is formed by directing a beam of ions of opposite-type conductivity having at least one surface of the silicon substrate of said one-type conductivity. Then, forming by ion implantation the first region of opposite-type conductivity which is fully enclosed laterally by said second silicon substrate. This region is formed by directing a beam of ions of opposite-type conductivity having at least one surface of the silicon substrate of said one-type conductivity.

Finally, the ion beam energy level is at least one MeV, and said second region is at least one micron below the surface. It is further preferable that the energy and dosage levels of the beam of ions are selected so that the opposite-type conductivity impurity has a more peaked distribution gradient between the peak and the surface than between the peak and the junction of the first region with the substrate.

13 Claims, 8 Drawing Figures





US-PAT-NO: 5986327

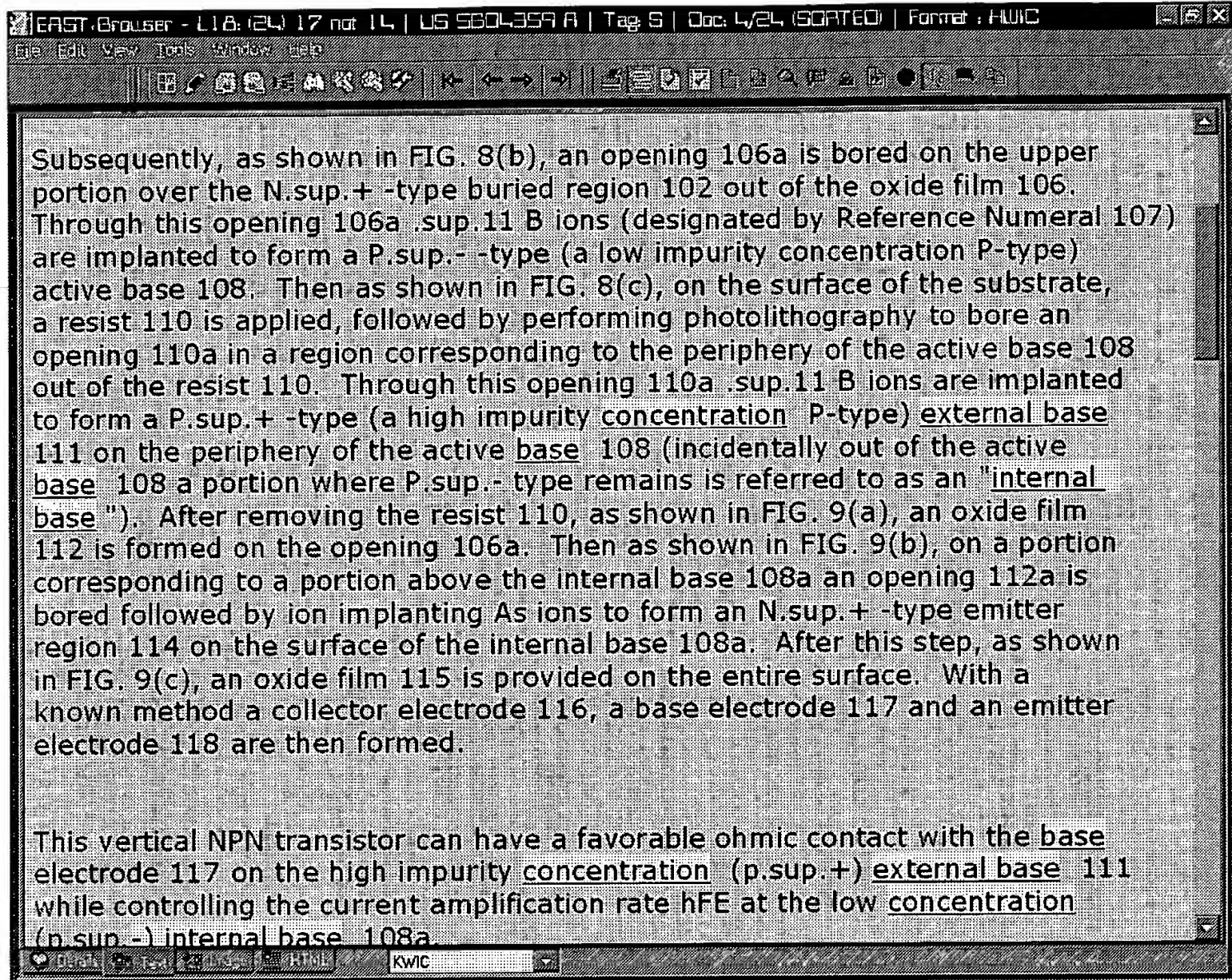
DOCUMENT-IDENTIFIER: US 5986327 A

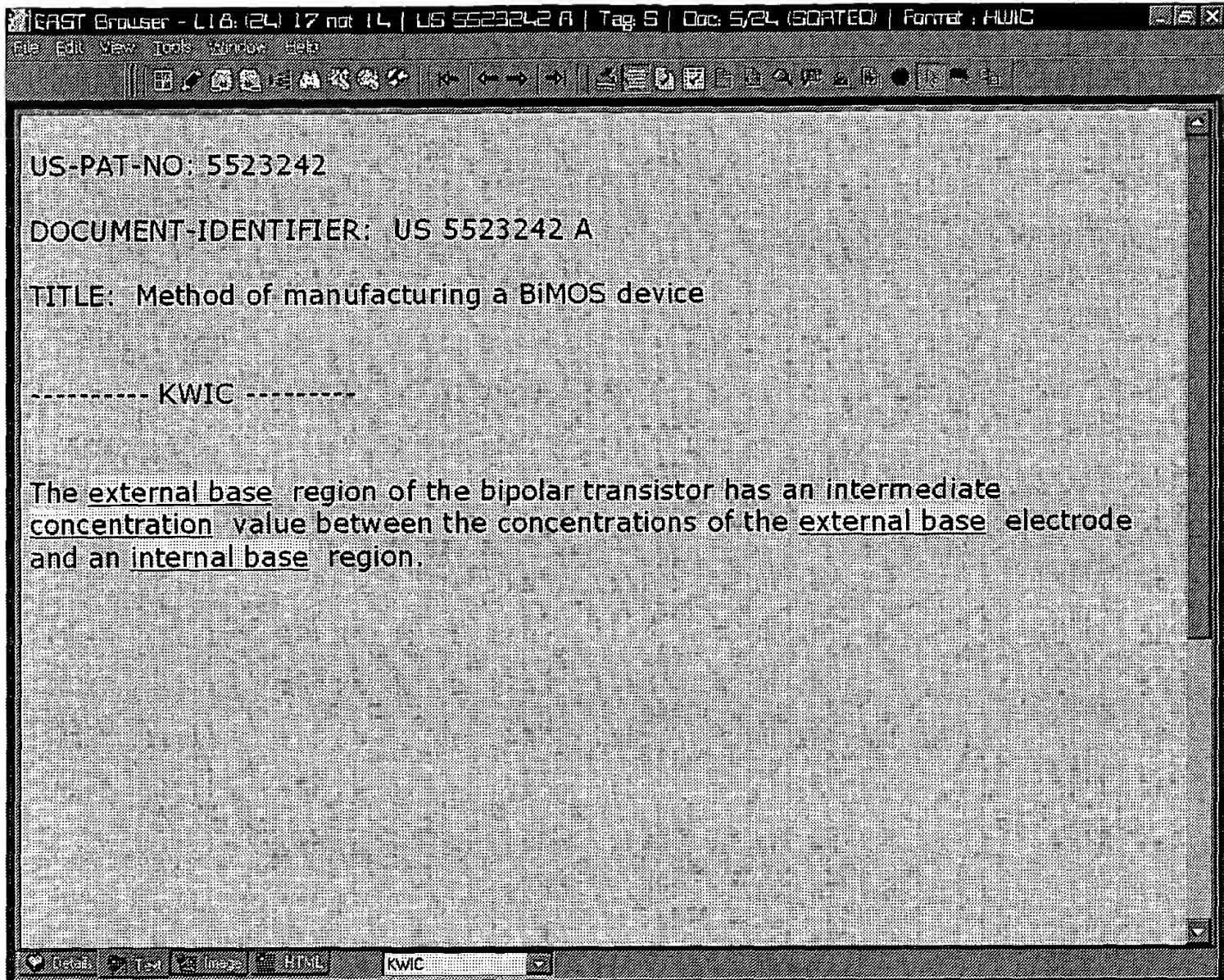
TITLE: Bipolar type diode

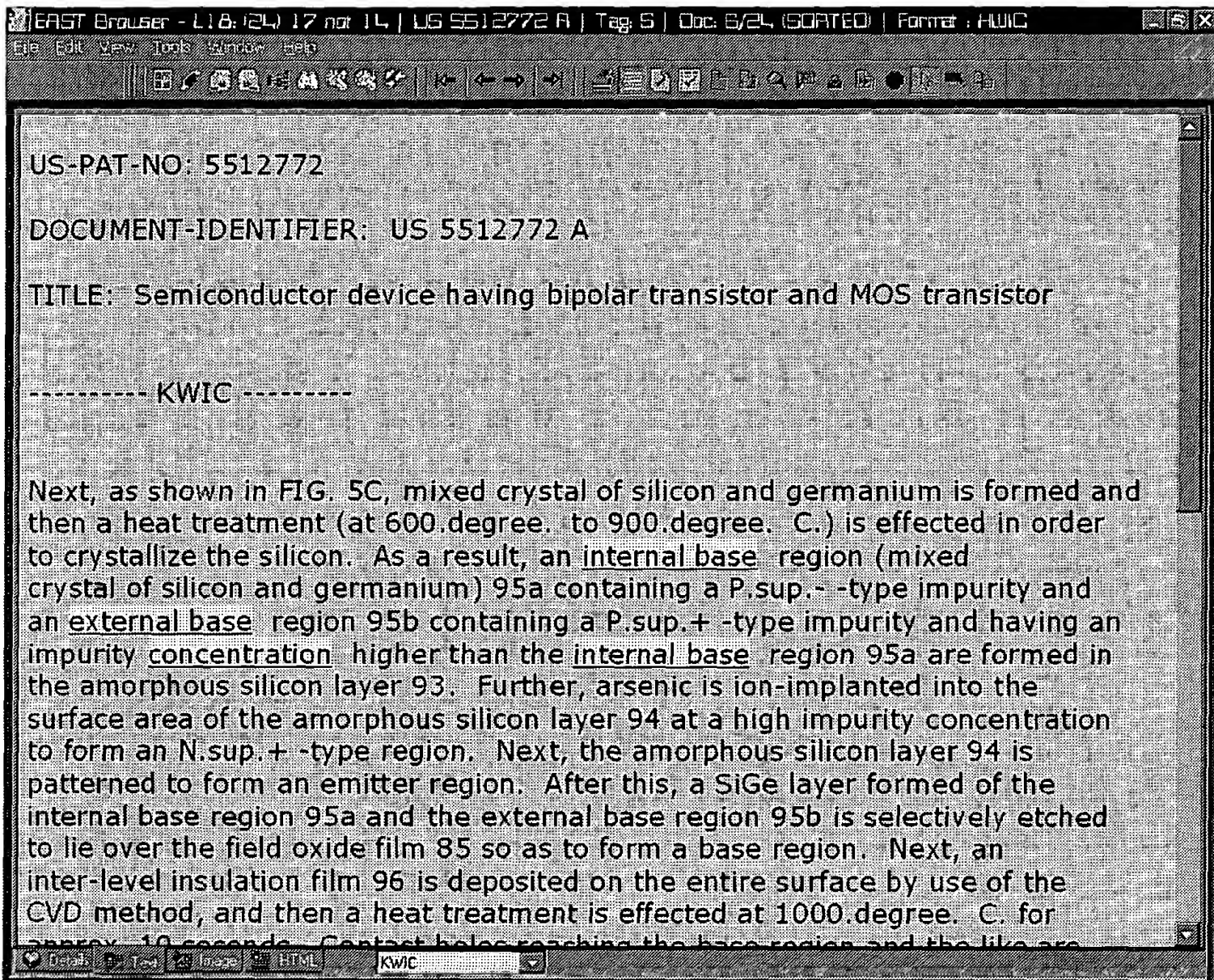
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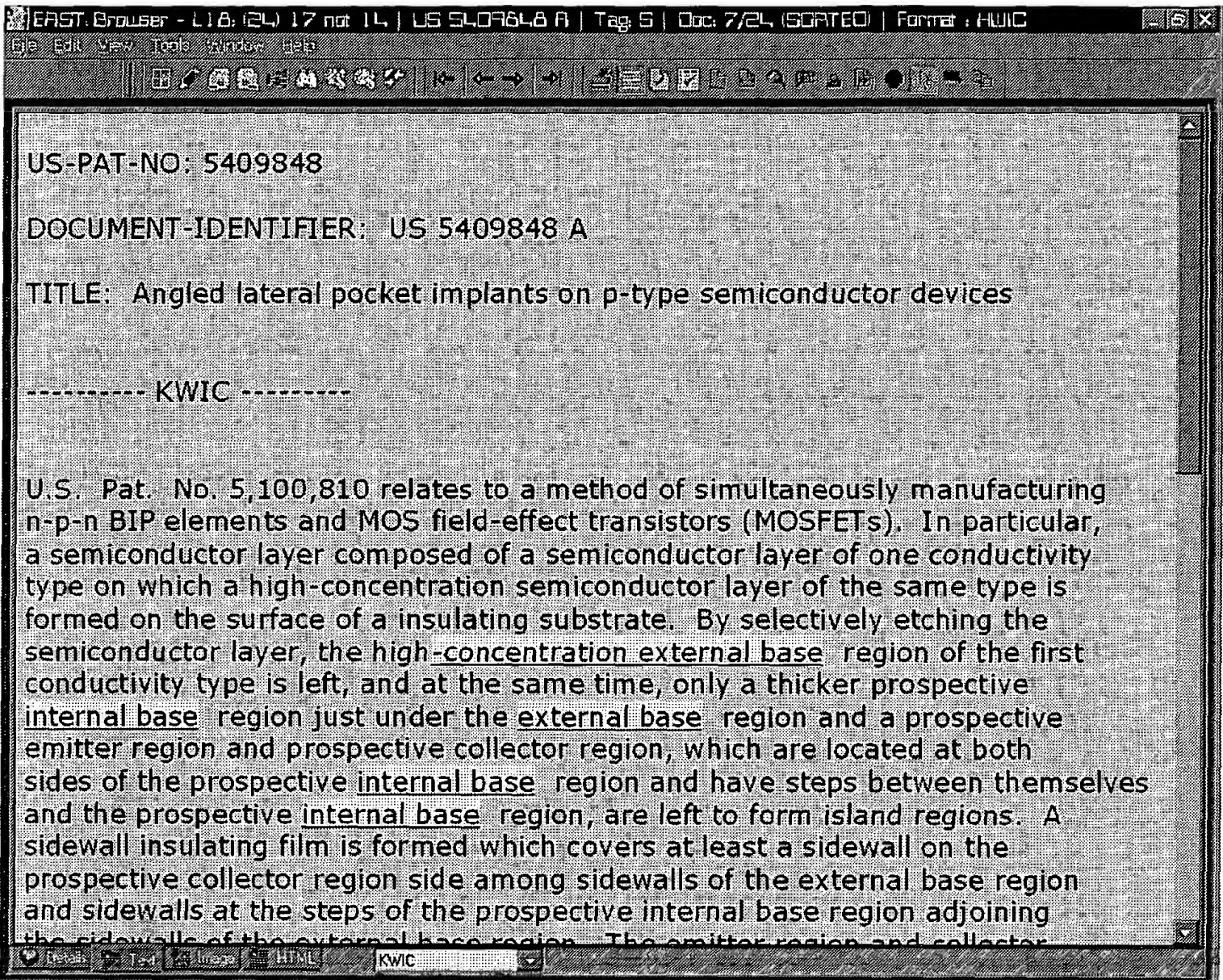
In the diode shown in FIG. 7, an emitter region 5 and base region 4 are formed over a silicon semiconductor substrate 1, the concentrations of the emitter and base regions having the same level as those in FIG. 1 but, here, an internal base region 16 and external base region 17 are formed over the substrate, an aspect which is different from that shown in FIG. 1. Further, a phosphorus (P) of about 10^{20} /cm^3 is diffused to provide a collector contact 18. The internal base region 16 has a junction depth X_j of 0.5 to 0.6 μm and concentration of 10^{17} /cm^3 and the external base region 17 has a junction depth X_j of 0.7 to 0.8 μm and concentration of 10^{18} /cm^3 .

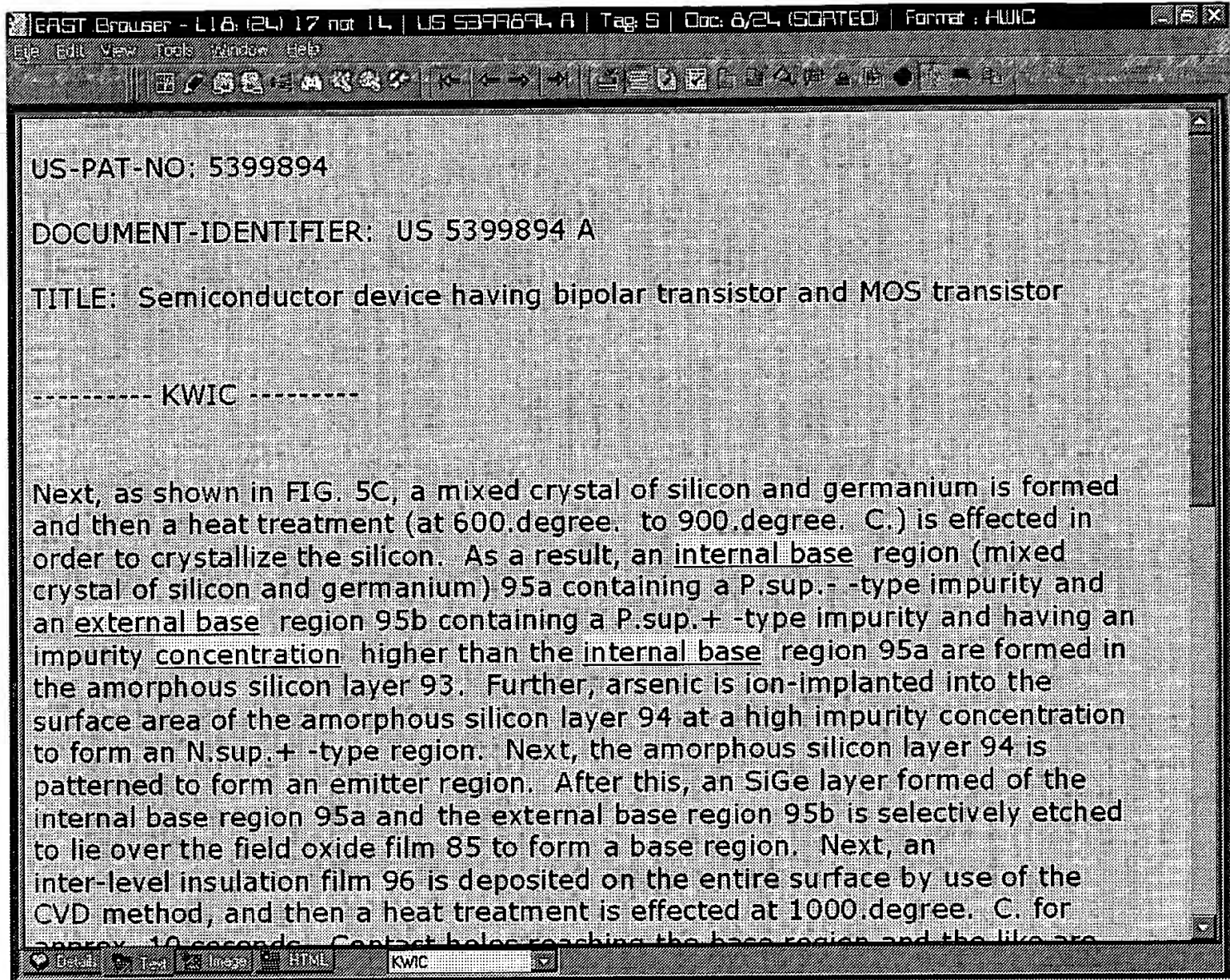
FIG. 14 is a cross-sectional view showing a major section of a bipolar IC device incorporating the aforementioned zener diode therein. Island areas are formed in an N type epitaxial layer 30a of a P type polysilicon semiconductor substrate 20 in a manner to be isolated by P type isolation areas 21. An NPN

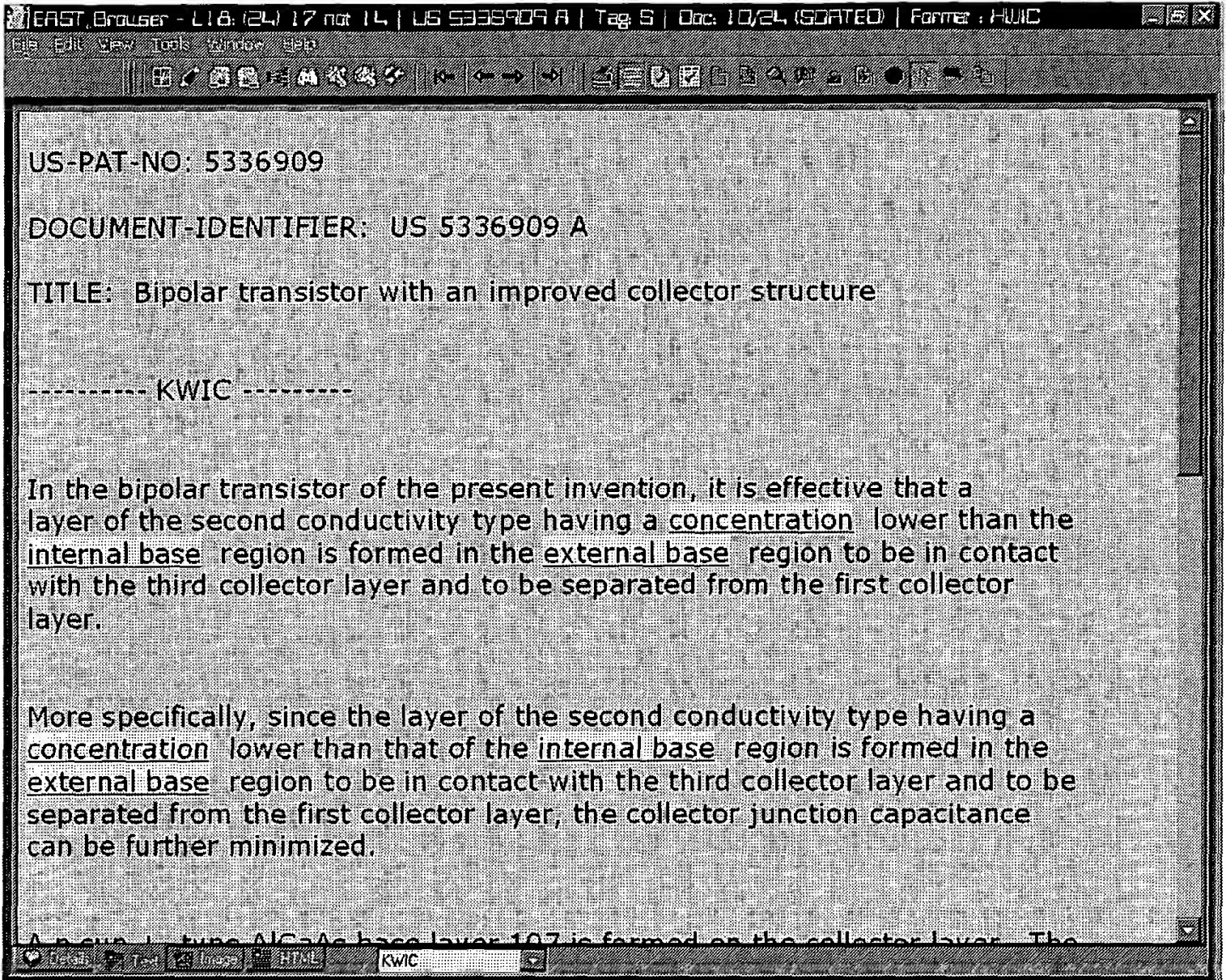












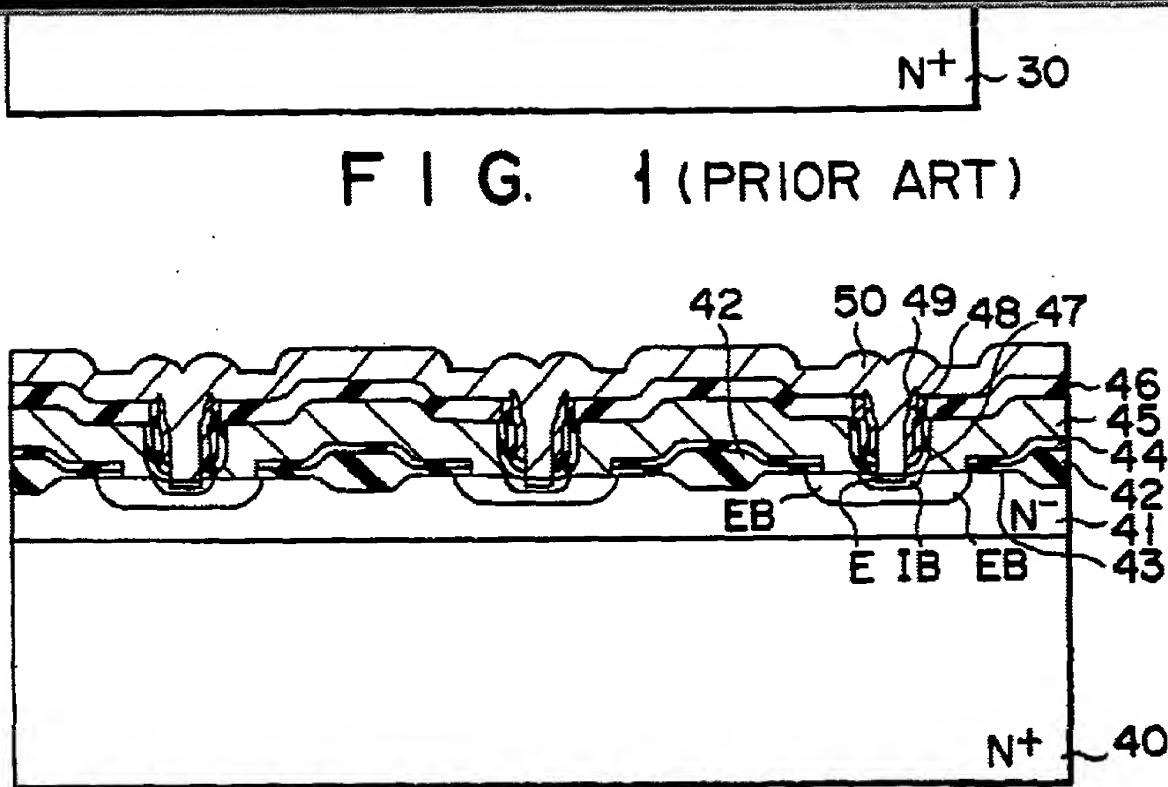


FIG. 2 (PRIOR ART)